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Mission Highlights STS-72

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Teamwork is key to success for *Endeavour* mission

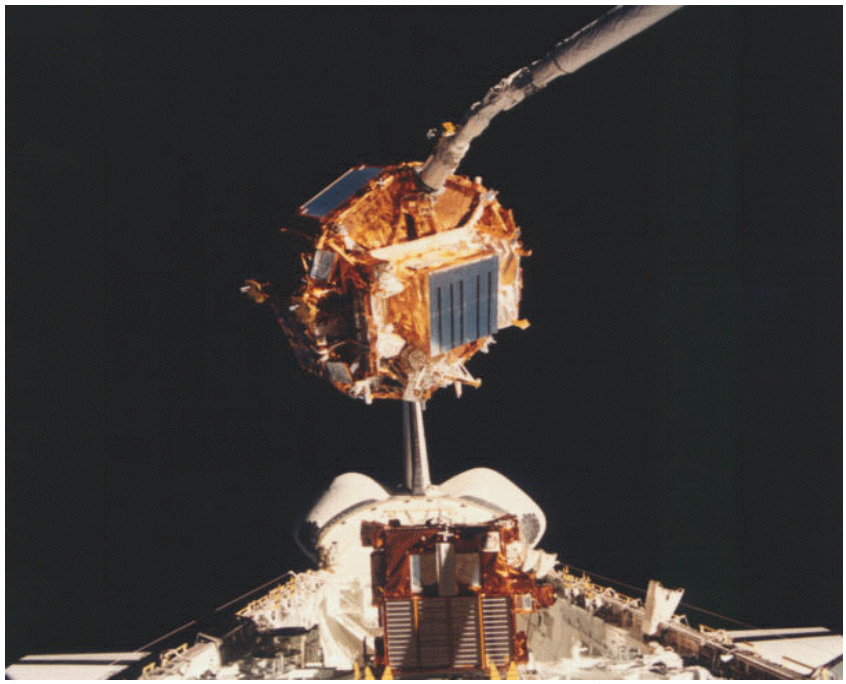
Two space walks, cooperation between two nations and testing of techniques for the future International Space Station (ISS) project marked the first mission of 1996. The six member crew on-board the Space Shuttle *Endeavour* combined its talents with the ground control team to successfully complete the multipurpose nine-day mission.

On flight day three of STS-72, Commander Brian Duffy and Pilot Brent Jett maneuvered *Endeavour* toward the Japanese Space Flyer Unit (SFU) and Mission Specialist Koichi Wakata plucked the satellite from its orbit and placed it in the shuttle's cargo bay. The berthing and return of the satellite accomplished the primary mission goal and completed a mission begun by the Japanese 10 months before.

NASA's extensive work to prepare astronauts and engineers for assembly of the International Space Station continued on STS-72. Mission Specialists Leroy Chiao, Dan Barry and Winston Scott spent more than 13 hours in space testing tools and techniques that future space walkers will use to assemble the station in low-Earth orbit.

When the crew returned to Ellington Field in Houston, TX, they were greeted by a surprise visitor, President Bill Clinton.

"I am so glad that I happen to be in Houston and at the airport at the right time," Clinton told the crowd that had gathered to welcome home the six astronauts. "On behalf of the people of the United States, we are very proud of this mission, proud of this crew, we



Crew members captured this view of the Japanese Space Flyer Unit (SFU) during its berthing with the Remote Manipulator System. Yet to be deployed is the OAST Flyer Satellite seen at bottom center.

Space Shuttle *Endeavour*

January 11-20, 1996

Commander:	Brian Duffy
Pilot:	Brent Jett
Mission Specialists:	Leroy Chiao Winston Scott Koichi Wakata Daniel Barry

Commander Brian Duffy and Pilot Brent Jett check the latest batch of mail uplinked from ground controllers in Houston, Texas.

were thrilled by its success and we're glad to have them home."

Clinton took a few moments to congratulate the agency for its cooperative efforts and its scientific successes.

"Our space program is an important part of our partnership for world peace. It is an important part of how we relate to and work with the Japanese, the Russians and others in building a more cooperative, safer world.

"Our space program also is an important part of research we do in trying to solve medical and environmental mysteries," he added. "NASA has been a major, major force in helping us to figure out ways to save our planet Earth as we accommodate more population and economic growth. So I ask all of you, remain steadfast in support for America's investment in space and in our future together with our friends and allies throughout the world."

STS-72 Commander Brian Duffy was overwhelmed by the reception. "What a flight, what a mission. I think the work we did over the last nine days will continue well into the future. This flight can best be summed up by the word teamwork. It began right from the start, when the NASA and NASDA folks were getting together and reached its apex during this last week when the ground team did just a great job," Duffy said.

Pilot Brent Jett reflected on how he had to learn to do basics in space. "For a first time flyer, this was a real exciting mission. There were a lot of things I had to learn about, living in space."

Mission Specialist Koichi Wakata greeted his friends and colleagues. "The success of this mission would not have been possible without the efforts of Mission Control, people from the Japanese SFU project in Japan and the support of the Japanese Space Agency."

Mission Events

Endeavour rocketed into the Florida sky on January 11, 1996, at 3:41 a.m. CST. The launch was delayed 23 minutes due to communication configuration problems between the Mission Control Center in Houston and ground control stations near the launch site. The problems were quickly resolved and *Endeavour* embarked on its 10th flight to begin the new year with the 74th shuttle launch in the program's history.

Crew members spent their first full day in orbit activating secondary experiments and checking out the space suits they would wear during a pair of 6 1/2 hour space walks. At 1:38 a.m., Duffy and Jett conducted a brief firing of the orbiter's reaction control system jets to alter *Endeavour's* orbit slightly and avoid a close encounter with an orbiting Air Force satellite nicknamed MISTY (MSTI). The satellite was launched in May 1994 but was no longer active. With the maneuver, *Endeavour* remained more than five miles away from MSTI.

During their second day in space, Jett and Wakata performed a survey of the cargo bay using the shuttle's robot arm, finding everything in excellent shape. Astronauts Chiao, Scott and Barry checked out the space suits and space walking gear they would need for the two space walks.

On day three, Wakata used *Endeavour's* robot arm to retrieve the Japanese SFU satellite at 4:57 a.m. CST. Berthing of the SFU was completed at 5:39 a.m. The retrieval followed jettison of both solar arrays when sensors indicated the panels did not latch properly against the satellite after being retracted. The canisters housing the arrays were jettisoned 12 minutes apart at 3:35 and 3:47 a.m. The retrieval of SFU capped off 10 months of scientific investigations involving almost a dozen experiments ranging from materials science to biological studies.

To begin day four of the mission, the OAST-Flyer was deployed by Wakata at 5:32 a.m. CST. The OAST-Flyer contained four experiments that studied spacecraft contamination, the use of the Global Positioning System for spacecraft attitude control, laser-initiated pyrotechnic devices in the environment of space, and an amateur radio experiment to allow radio operators on the ground to track the satellite.

The first of two space walks was the focus of day five as astronauts Chiao and Barry spent more than six hours in *Endeavour's* cargo bay testing tools and techniques to be used in the construction of the ISS. The two astronauts floated out of the shuttle's airlock at 11:35 p.m. to begin the 31st space walk in shuttle history. The first-time space walkers spent the next six hours and nine minutes testing out tools and techniques that would be used in the construction of the ISS. They stayed ahead of their timeline throughout the night, concluding their space walk at 5:44 a.m.

On day six, Wakata extended *Endeavour's* robot arm and plucked a NASA science satellite out of orbit to successfully complete the second satellite retrieval of the STS-72 mission. The 2,600-pound OAST-Flyer satellite was grappled at 3:47 a.m. Within minutes of capturing the satellite, Wakata lowered the satellite onto its truss platform in the cargo bay, just as he had done with the Japanese SFU following its retrieval.

The second space walk of the STS-72 mission began at 11:54 p.m. on day seven. Astronauts Chiao and Scott tested connectors, cables and work platforms in the shuttle's cargo bay. The space walk concluded at 6:34 a.m., with the astronauts logging 6 hours 53 minutes and 41 seconds working in the vacuum of space. Late in the space walk, Scott climbed into foot restraints on the OAST-Flyer satellite platform for the thermal evaluation exercise. *Endeavour* was maneuvered to the coldest position possible, with its payload bay facing out toward deep space and allowing temperatures to dip to about 104 degrees below zero to test the ability of his space suit to repel the bitter cold of space.

On day eight, astronauts completed some secondary experiments in the middeck and stowed several space walk tools. With all mission objectives accomplished, *Endeavour's* astronauts used day nine to pack up their ship for its return trip back to Earth. In the predawn hours, the shuttle swooped to an on-time landing at 1:42 a.m. CST at the Kennedy Space Center completing a 3.7 million mile flight.

Additional Payload Descriptions

The first major activity of the STS-72 mission was the retrieval of the Japanese Space Flyer Unit (SFU), which was launched aboard a Japanese H-2 rocket to conduct a variety of microgravity experiments. Commander Duffy positioned the shuttle for the capture of the SFU, while mission specialist Wakata moved the mechanical arm to grab the grapple fixture and capture the satellite. The satellite was then placed in the shuttle's cargo bay for its return to Earth.

Spartan Project: This project was designed to provide easy and inexpensive access to Earth orbit via the space shuttle for science experiments that need to take measurements in orbit but away from the shuttle. Initiated by the then-Office of Aeronautics and Space Technology at NASA Headquarters (OAST) and currently sponsored by the Office of Space Access and Technology (OSAT), the OAST-Flyer was composed of four experiments: Two of the four experiments, REFLEX and GADACS, were sponsored by OSAT. SELODE was sponsored by the Office of Safety and Mission Assurance and the fourth experiment, SPRE, was a volunteer effort comprised of University of Maryland students, area engineers, and space industry contractors.

Return Flux Experiment (REFLEX): The main objective of REFLEX was to investigate molecular backscattering or "return flux," associated with on-orbit spacecraft. This phenomenon occurs when spacecraft give off tiny particles of dirt into the atmosphere which then collide with other particles and bounce back to the spacecraft. Return flux was believed to be one of the factors that scientists have been unable to calculate into their computer-generated models.

Global Positioning System (GPS) Attitude Determination and Control Experiment (GADACS): This experiment used the Global Positioning System (GPS) to determine the attitude of Spartan, the location and velocity of the spacecraft, and provide accurate timing for one portion of the Spartan mission. Until GADACS, spacecraft used costly gyroscopes, star trackers, or Sun or Earth sensors to determine their attitude. The experiments on GADACS paved new trails for lighter, less costly missions of the future.

Solar Exposure to Laser Ordnance Device (SELODE): A new family of pyrotechnic devices was developed using a laser pulse traveling through a fiber optic cable to trigger the explosive charge. This eliminated the concern of accidental firing from stray electrical energy sources. SELODE was developed to test the safety and reliability of five different types of laser ordnance devices. The primary investigation centered on the effects of direct and concentrated sunlight in the space environment on different explosives and design methods. Flight testing evaluated accidental firing levels, and post-flight testing examined the effects of exposure on the chemical stability of the explosives.

Spartan Packet Radio Experiment (SPRE): SPRE was an amateur radio communications experiment. The primary mission was to test satellite tracking using amateur packet radio and a GPS. SPRE was developed and built by the University of Maryland Amateur Radio Association with assistance from NASA, volunteer engineers, and software professionals. This type of technology has many applications in both the amateur radio and commercial world. Low cost Low Earth Orbit satellites could be used to track storms, weather balloons, boats at sea, trucks, etc

Shuttle Solar Backscatter Ultraviolet (SSBUV): The SSBUV instrument was designed to measure ozone concentrations by comparing solar ultraviolet radiation with radiation scattered back from the Earth's atmosphere. SSBUV results were compared with the observations of several ozone measuring instruments. The SSBUV data were used to calibrate the instruments to ensure the most accurate readings possible for the detection of atmospheric ozone trends. Goddard Space Flight Center was the principal investigator, and the Aerospace Engineering Group of IDEA Inc., was the mission manager. SSBUV is managed by Goddard for NASA1s Office of Mission to Planet Earth, Washington, DC.

Astronaut Leroy Chiao gives a thumbs up signal, marking the success of his second extravehicular activity in three days.

Astronaut Koichi Wakata takes advantage of the microgravity environment on the mid-deck of *Endeavour.*

Shuttle Laser Altimeter Payload (SLA-01): The SLA-01 was used to precisely measure the distance between the Earth's surface and the space shuttle. It worked by transmission of a series of short laser pulses from the payload in the shuttle cargo bay and by the subsequent reception of weak, laser pulse echoes from the Earth's surface. Primary data was obtained on each laser pulse's time-of-flight and the pulse distortion and pulse broadening caused by reflection from the Earth's surface. Measurable pulse echoes are expected from land surfaces, vegetation, ocean surfaces, and cloud-tops.

Data from the pulse echoes have wide applications in a variety of Earth-science disciplines ranging from topography studies to measurement of tree heights and cloud tops. The SLA instrument was developed by Goddard's Laboratory for Terrestrial Physics and was sponsored by NASA Headquarters' Mission to Planet Earth, Flight Systems Division.

The Flexible Beam Experiment 2 (FLEXBEAM 2): Vibrations in space are a nuisance. Since space is virtually void of any atmosphere, there is no medium to dampen structural oscillations. Oscillations can be dampened by mass and springs, reaction jets, or oscillators. However, what if the reaction jets fail, springs break, or actuators can't fit into the mission? Do we even need dampers? How long will certain materials vibrate in a micro-gravity, vacuum environment? These are just a few worries for designers of solar arrays and space stations in orbit. The Flexible Beam Experiment (FLEXBEAM) flew on STS-72 as a Get Away Special (GAS) payload, and investigated these questions as it measured the evaporation rate of solid-to-vapor and transporation rate of the vapor Mercuric Iodide under microgravity. The principal investigator for this experiment was the United States Air Force Academy. The NASA Goddard Space Flight Center was the technical manager.

Protein Crystal Growth: The microgravity environment is suitable to make well-ordered protein crystals for X-ray diffraction analysis and three-dimensional structure determination. But, it is still unclear why microgravity is effective. In previous microgravity experiments, there was evidence that nucleation provability of crystal forms and X-ray resolution (index of crystal order) were affected by microgravity.

In this payload, the effect of the microgravity environment on protein-crystal nucleation was examined. The principal investigator was the Society of Japanese Aerospace Companies, Inc, and the NASA Technical Manager was Goddard Space Flight Center.

Extravehicular Activity Development Flight Test-03 (EDFT-3): On the first space walk of STS-72, Chiao and Barry conducted evaluations of a new Portable Work Platform (PWP), an EVA workstation for astronauts that provided an aid for temporarily restraining replacement units and equipment the space walker may be working with; a movable stanchion that provided stability for the astronaut and holders for tools; and a flexible foot restraint. They also evaluated the installation of a rigid umbilical that may be used on the space station to hold various fluid and electrical umbilicals in place. The Rigid Umbilical (RU) also was used for evaluations of the handling of large masses while space walking.

The second space walk, conducted by Chiao and Scott, consisted mainly of evaluations of a space station Utility Box, a box designed to hold avionics and fluid line connections on the station; an on-orbit installed slidewire, a type of wire to which EVA tethers can be connected on the exterior of the space station; measurements of forces induced by various space walking work such as replacing station components and manipulating massive objects; and an evaluation of thermal improvements to the space suits. In addition, an Electronic Cuff Checklist (ECC), a wrist-mounted portable computer planned to supplement written checklists for space walks, was evaluated.

Equipment Evaluations: The space suit thermal modification tests included gloves with electrically warmed fingers, thermal socks, thermal toe caps inserted in the space suit boots. In addition, the space suits allow a space walker to completely shut off cooling water to the Liquid Cooling and Ventilation Garment, thus providing maximum warmth.

The On-Orbit Installed Slidewire was a wire to be used for attaching EVA tethers while moving from one location to another, similar to permanently mounted wires running down the sides of the shuttle's cargo bay. Several slidewires will be installed on the exterior of station segments allowing the exterior of the segments to have fewer protrusions during launch and be more compact.

The Body Restraint Tether (BRT) was designed to hold a space walker steady in a variety of locations where a foot restraint is not available.

The Rigid Tether allowed astronauts to more easily carry large objects, such as a foot restraint, with them while they move from site to site. It hooked the equipment to their space suit and prevented it from swinging about.

The On-Orbit Installed Handrail was designed for installation on the exterior of the space station. It was secured by two sliding latches that lock it into position.

Several of the designs planned for warning labels to be mounted on the exterior of the space station were evaluated during STS-72. The caution labels were affixed to the exterior of equipment boxes used during the EVAs.

IN-CABIN PAYLOADS

Phisiological and Anatomical Rodent Experiment (PARE/NIH-R): PARE/NIH-R was a collaborative project developed by NASA and the National Institutes of Health. This series of experiments was designed to determine whether exposure to microgravity results in physiological or anatomical changes in rodents. The first three weeks of life are a period of tremendous development for newborn rats. The nervous system undergoes dramatic development during this period. Understanding how this development occurs in rats gives great insight into how normal neurological development occurs on Earth.

Space Tissue Loss (STL/NIH-C): The STL/NIH-C5 experiment was a middeck-locker experiment that investigatied the effect of space flight on musculoskeletal development at the cellular level. The objectives of the experiment were to validate models of muscle, bone, and endothelial cell biochemical and functional loss induced by microgravity stress. The experiment used a computerized tissue culture incubator known as the Space Tissue Loss Culture Module. The module was developed at the Walter Reed Army Institute of Research, Washington, D.C. Results of this research may lead to development of measures to maintain the strength of muscles and bones during long-duration space voyages and possibly on Earth.

Protein Crystal Growth (PCG): Crystals produced in the gravity environment of Earth are often too small and may have internal defects that make crystallographic analysis difficult or impossible. Some protein crystals grown in space are not only larger, but also have fewer defects than their Earth-grown counterparts. The primary objective was to produce large, high-quality crystals of selected proteins under controlled conditions in microgravity. The principal investigator for the PCG experiment was the University of Alabama at Birmingham.

Commercial Protein Crystal Growth - 8 (CPCG-8): CPCG was a protein crystal growth experiment using batch temperature-induction crystallization methodology to produce crystals of a new form of recombinant human insulin. Temperature induction allows protein saturation and subsequent crystal growth to proceed slowly in a predetermined manner in order to maximize crystal size and quality. This methodology is particularly effective in space because, in the unique environment of microgravity, disruptive convection currents resulting from temperature change are minimized. The protein sample processed on this flight was a new form of recombinant human insulin whose parent molecule, insulin, is used for the treatment of type I diabetes ("juvenile-onset").

CREW BIOGRAPHIES

Commander: Brian Duffy (Col. USAF). Duffy, 42, was born in Boston, MA. He received a bachelor of science degree in mathematics from the U.S. Air Force Academy, and a master of science degree in systems management from the University of Southern California.

Duffy participated in the development and testing of computer software to be used on shuttle flights, served as technical assistant to the director of Flight Crew Operations, developed displays and flight crew procedures used during the ascent phase, and spacecraft communicator (CAPCOM) in Mission Control during numerous shuttle missions, and also worked on ISS issues.

Duffy was the pilot on STS-45, the first of the ATLAS series of missions to address the atmosphere and its interaction with the Sun. He also was the pilot on STS-57. Mission highlights included retrieval of the European Retrievable Carrier with the shuttle's robotic arm, a space walk by two crew members, and an assortment of experiments in the first flight of the Spacehab middeck augmentation module. With the completion of STS-72, he has logged more than 667 hours in space.

Pilot Brent W. Jett, Jr. (Lt. Cdr., USN): Jett, 37, was born in Pontiac, MI, but considers Ft. Lauderdale, FL, to be his hometown. He received a bachelor of science degree in aerospace engineering from the U.S. Naval Academy, and a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School.

Jett's NASA experience included work on technical issues for the Operations Development Branch of the Astronaut Office and serving as the ascent/entry CAPCOM in Mission Control. With the completion of this flight Jett has logged more than 214 hours in space.

In-flight crew portrait on the aft deck. Front row (l to r), Daniel Barry, Brian Duffy and Leroy Chiao. Back row (l to r), Koichi Wakata, Brent Jett and Winston Scott.

STS-72 Quick Look

Launch Date: January 11, 1996
Time: 3:41 a.m. CST
Site: KSC Pad 39B

Orbiter: *Endeavour*
OV-105-10th flight
Orbit/In.: 250 naut. miles
28.45 degrees

Mission Duration: 8 days, 22 hrs,
Landing Date: Jan. 20, 1996
Time: 1:42:55 a.m. CST
Site: Kennedy Space Center

Crew: Brian Duffy, (CDR)
Brent Jett, (PLT)
Leroy Chiao, (MS1)
Winston Scott, (MS2)
Koichi Wakata, (MS3)
Daniel Barry, (MS4)

Cargo Bay Payloads: OAST Flyer
Space Flyer Unit
SSBUV
EDFT-03
SLA-01/GAS

In-Cabin Payloads: NIH-R
STL/NIH-C
PCG-STES
CPCG

The STS-72 patch depicts the Orbiter *Endeavour* and some of the payloads on the flight. The Japanese satellite space flyer Unit (SFU) is shown in a free-flying configuration with the solar array panels deployed. The inner gold border of the patch represents the SFU's octagonal shape. *Endeavour* rendezvoused with and retrieved SFU at an altitude of approximately 250 nautical miles. The Office of Aero-nautics and Space Technology's (OAST) flyer satellite is shown just after release from the remote manipulator system. The OAST satellite was deployed at an altitude of 165 nautical miles to fly free for two days gathering scientific data. The payload bay contains equipment for the secondary payloads: the Shuttle Laser Altimeter and the Shuttle Solar Backscatter Ultraviolet Instrument. The stars represent the crew's hometowns in the United States and Japan.

Mission Specialist Leroy Chiao (Ph.D.): Chiao, 35, was born in Milwaukee, WI, but considers Danville, CA, to be his hometown. He received a bachelor of science degree in chemical engineering from the University of California, Berkeley, and a master of science degree and a doctorate in chemical engineering from the University of California, Santa Barbara.

Chiao participated in space shuttle flight software verification in the Shuttle Avionics Integration Laboratory; crew equipment, Spacelab, Spacehab and payloads issues for the Astronaut Office Mission Development Branch; Training and Flight Data File issues. Chiao also served as a mission specialist on STS-65 which flew the second International Microgravity Laboratory. During the 15-day flight, the crew conducted more than 80 experiments focusing on materials and life sciences research in microgravity. With the completion of STS-72, he has logged more than 567 hours in space including more than 13 hours of EVA.

Mission Specialist Winston E. Scott (Captain, USN): Scott, 45, was born in Miami, FL. He received a bachelor of arts degree in music from Florida State University and a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School.

Scott's NASA assignments included to the Astronaut Office Mission Support Branch, serving with the Astronaut Support Personnel team supporting space shuttle launches and landings at the Kennedy Space Center in FL. With the completion of this flight, Scott had logged more than 214 hours in space including more than 6 hours of EVA.

Mission Specialist Koichi Wakata (NASDA): Wakata, 33, was born in Omiya, Saitama, Japan. He received a bachelor of science degree in aeronautical engineering from Kyushu University; and a master of science degree in applied mechanics from Kyushu University.

Wakata's technical assignments included payload science support for the Astronaut Office Mission Development Branch and space shuttle flight software verification testing in the Shuttle Avionics Integration Laboratory. He has now logged more than 214 hours of space flight with the U.S. space program.

Mission Specialist Daniel T. Barry (M.D., Ph.D.): Barry, 42, was born in Norwalk, CT, but considers South Hadley, MA, to be his hometown He received a bachelor of science degree in electrical engineering from Cornell University; a master of engineering degree and a master of arts degree in electrical engineering/computer science from Princeton University; a doctorate in electrical engineering/computer science from Princeton University; and a doctorate in medicine from the University of Miami.

Barry has worked on primary payloads for the Mission Development Branch of the Astronaut Office, worked in the Shuttle Avionics Integration Laboratory, portable computing issues for space shuttle, and as Chief of Astronaut Appearances. With the completion of this flight, Barry has logged more than 214 hours in space including more than 6 hours of EVA.